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EFFECTS OF AN INTERVENTION ON THE INTERPERSONAL MOTIVACIONAL CLIMATE GENERATED BY THE PHYSICAL EDUCATION TEACHER

Efectos de una intervención sobre el clima interpersonal motivacional generado por el docente de Educación física

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Abstract:

The aim of this study was to examine the effects of changes in the motivational interpersonal climate created by the Physical Education (PE) teacher on students' motivational variables. A quasi-experimental design with pre-test and post-test measures was used, and several motivational variables were analysed in 64 students (M age = 12.14; SD = 0.39) divided into a control group (n = 19) and an experimental group (n = 45). The results showed that, after the teaching intervention, there were significant improvements in both the teacher's leadership style and basic psychological need support in the experimental group. In addition, satisfaction of basic psychological needs, more self-determined forms of motivation and intention to be physically active also improved significantly. In short, the intervention on the PE teacher's interpersonal style led to improvements in several motivational variables among students. Nevertheless, further studies are needed to determine which teaching strategies are most effective in improving students' motivation during PE lessons.

Keywords: ***basic psychological needs; leadership; motivation; secondary education; teacher.***

Resumen:

El objetivo del estudio fue examinar los efectos del cambio en el clima interpersonal motivacional del docente de Educación Física (EF) sobre el alumnado en las diferentes variables motivacionales. Para ello, se empleó un diseño cuasi-experimental con medidas pretest y postest, donde se analizaron diferentes variables motivacionales en 64 alumnos y alumnas (*M* edad = 12.14; *DT* = 0.39) divididos en un grupo control (n = 19) y un grupo experimental (n = 45). Los resultados mostraron que, tras la intervención docente, hubo mejoras significativas tanto en el estilo de liderazgo del profesorado, como en el apoyo de las necesidades psicológicas básicas en el grupo experimental. Por otro lado, tanto la satisfacción de las necesidades psicológicas básicas, las motivaciones más autodeterminadas como la intención de ser físicamente activo mejoraron significativamente. En definitiva, la intervención sobre el estilo interpersonal del docente de EF produjo mejoras en diferentes variables motivacionales de su alumnado. A pesar de ello, es necesario realizar más estudios para determinar qué estrategias didácticas son más efectivas para mejorar la motivación del alumnado durante las clases de EF.

Palabras clave: ***necesidades psicológicas básicas; liderazgo; motivación; Educación Secundaria; profesorado.***

1. Introduction

Scientific evidence is showing that the amount of physical activity performed by adolescents is insufficient (Guthold et al., 2020; Santos-Labrador, 2019). In Spain, 17.91% of boys aged between 15 and 24 are sedentary, meaning that they do not engage in any physical activity, while in the case of girls this value rises to 31.89% (Instituto Nacional de Estadística, 2021). This is highly concerning, as sedentary behaviour is associated with various negative health consequences in children and adolescents (Wilhite et al., 2023).

Sevil-Serrano et al. (2020) showed in their study that schools are a key context in which to promote students' physical activity. In this regard, the learning environment created by teachers in Physical Education (PE) lessons is essential for fostering students' participation, and one of the determining factors in achieving this is the teacher's leadership (Moreno-Casado, 2023). Leadership is a fundamental quality enabling teachers to activate mechanisms that allow students to enhance their motivation, performance, and well-being (Torralba et al., 2022). Along these

lines, Alsina and Mallol (2021), when analysing different forms of leadership in Secondary Education settings, point out that the most innovative approaches focus on transformative and distributive models, also highlighting the link between leadership style and teacher motivation. Research has likewise demonstrated that teacher motivation affects students' motivation (e.g., Ahn et al., 2021; Radel et al., 2010).

Real-Pérez et al. (2021) argue that students' lack of motivation and engagement in PE lessons is one of the greatest challenges for teachers. In this respect, motivation plays an important role in PE, as it can encourage physical activity participation outside the school setting (Sevil-Serrano et al., 2014). Most studies addressing this topic, both nationally (e.g., Franco & Coterón, 2017) and internationally (e.g., Cheon et al., 2016), adopt Self-Determination Theory (SDT; Ryan & Deci, 2017) as their theoretical framework. Unlike classical theories, SDT conceptualises motivation from both a quantitative and qualitative perspective. This distinctive feature makes it one of the most important contemporary theories for studying motivation in educational contexts (López-García et al., 2024).

Findings from applied educational research have enabled SDT to outline the following motivational sequence: (1) interpersonal style or climate (generated by the teacher); (2) satisfaction or frustration of students' basic psychological needs; (3) types of motivation (intrinsic motivation, extrinsic motivation and amotivation); and (4) consequences (including well-being, adherence to physical or sports activity, and other health-related behaviours) (Ryan & Deci, 2017).

According to this model, SDT proposes that the social context, especially the teacher's influence, can affect students through two very different interpersonal styles: autonomy-supportive and controlling. The interpersonal style involves generating various pedagogical elements—such as goal-setting or communication with students—that facilitate the fulfilment of basic psychological needs, which are essential for students' well-being and personal growth (Fierro-Suero et al., 2020). The controlling style is characterised by teachers using external pressures, which reduces students' initiative, whereas the need-supportive style refers to a set of strategies aimed at fostering students' initiative and personal development (Trigueros-Ramos et al., 2019). In other words, SDT assumes that social factors (in this case, the PE teacher) can facilitate or hinder more self-determined or autonomous forms of motivation through the satisfaction or frustration of basic psychological needs (Ryan & Deci, 2017).

As noted above, SDT posits that all individuals possess three basic psychological needs—autonomy, competence, and relatedness—which must be satisfied in any context in which they interact. Ryan and Deci (2017) define autonomy as the need to feel the origin and regulator of one's own actions; competence as the need to achieve desired outcomes and experience mastery and effectiveness; and relatedness as the need to feel able to interact with others in a secure and socially connected manner. Additionally, some authors (e.g., González-Cutre & Sicilia, 2019) suggest incorporating a fourth need into SDT: novelty, defined

as the need to encounter experiences not previously lived or different from those that form part of daily routines (González-Cutre et al., 2016).

Numerous studies have tested SDT's motivational sequence (interpersonal climate – satisfaction/frustration of basic psychological needs – motivation – consequences) in PE contexts, as shown by Vasconcellos et al. (2020) in their meta-analysis, in which an interpersonal climate supportive of basic psychological needs (promoted by the PE teacher) is positively related to the satisfaction of the needs for autonomy, competence and relatedness among students. In turn, satisfaction of these three needs predicts more autonomous motivation (intrinsic motivation and identified regulation), and these motivational regulations are associated with more adaptive outcomes in students, such as academic performance, learning, well-being, and intention to be physically active.

Intervention studies providing specific PE teacher training on motivation have proven effective, but training programmes tend to vary in characteristics such as duration, strategies used, and follow-up (Fernández-Espínola et al., 2022). In this regard, it has been shown that PE teachers can improve their students' motivation (García-González, 2021), but systematic and personalised training tailored to teachers' needs is required, following, for instance, the motivational strategies recommended by Ahmadi et al. (2023).

Recently, several studies have shown associations between PE teachers' transformational leadership and motivational climate (Castillo et al., 2020), autonomy-supportive interpersonal style (Domínguez-Montes et al., 2025), and students' satisfaction of basic psychological needs (Moreno-Casado et al., 2022). However, studies linking these constructs (leadership styles and motivational interpersonal climate) are still scarce, particularly those employing quasi-experimental designs. Therefore, the aim of this study was to analyse the effects of an SDT-based intervention/training programme for a PE teacher on transformational leadership/teaching, interpersonal style, need satisfaction, motivation, and students' intention to remain physically active. In this respect, considering the theoretical framework (SDT; Ryan & Deci, 2017) and previous studies (Castillo et al., 2020; Fernández-Espínola et al., 2022), the hypothesis proposed was that students in the experimental group would show a greater perception of their teacher's support for basic psychological needs (BPN), as well as higher scores in the dimensions of transformational leadership. Higher scores in BPN satisfaction, and consequently, higher levels of intrinsic motivation, identified regulation, and intention to be physically active were also expected.

2. Method

2.1. Study design

This study employed a quasi-experimental design with pre-test and post-test measures for both the control group (CG) and the experimental group (EG). To this end, a four-month intervention/training programme on motivational strategies was implemented with the PE teacher of the experimental group, and its effects on the students were evaluated.

2.2. Participants

A total of 64 students participated, drawn from an intentionally selected sample belonging to the first year of compulsory secondary education (1º ESO) in a public secondary school in the province of Seville. Their ages ranged from 12 to 14 years (M age = 12.14; SD = .39), with 30 male students (M age = 12.17; SD = .38) and 34 female students (M age = 12.12; SD = .41), and they were divided into a control group (n = 19) and an experimental group (n = 45). The difference in group size corresponded to the school's usual distribution of 1º ESO students, in which the experimental-group teacher was responsible for two classes (two groups), while the control-group teacher taught a single class. As for the teachers, convenience sampling was used. Two teachers from the same school participated: the EG teacher, a 43-year-old man with 17 years of teaching experience, and the CG teacher, a 28-year-old woman with 2 years of experience teaching secondary education.

2.3. Instruments

A questionnaire was used as the assessment instrument and was administered to students at two different time points (pre-test and post-test) to evaluate the following:

Transformational leadership or teaching. The Spanish version by Álvarez et al. (2018) of the Transformational Teaching Questionnaire (TTQ; Beauchamp et al., 2010) was used to measure the PE teacher's leadership style. The questionnaire comprises 16 items grouped into four factors: individual consideration (e.g., "Shows that he/she cares about me"), idealised influence (e.g., "Acts as a role model for me"), intellectual stimulation (e.g., "Teaches in a way that invites me to think"), and inspirational motivation (e.g., "Shows that he/she believes in me"). Items were preceded by the stem "My Physical Education teacher…" and answered on a five-point Likert scale from 1 (not at all) to 5 (frequently).

Basic Psychological Need-supportive climate in Physical Education. To analyse students' perceptions of need support provided by the PE teacher, we used the Questionnaire of BPN Support in PE validated by Fierro-Suero, Almagro, Castillo, and Sáenz-López (2020), in which the novelty factor was added to the original questionnaire by Sánchez-Oliva et al. (2013). The instrument contains 16 items grouped into four factors: autonomy support (e.g., "He/she often asks us about our preferences regarding the activities to be carried out"), competence support (e.g.,

"He/she proposes activities that are suited to our level"), relatedness support (e.g., "He/she fosters a good atmosphere among classmates"), and novelty support (e.g., "He/she does things differently from what we are used to"). The questionnaire used the stem "Our Physical Education teacher…" and items were answered on a five-point Likert scale from 1 ("strongly disagree") to 5 ("strongly agree").

Satisfaction of Basic Psychological Needs. We used the Spanish, PE-adapted version (Moreno et al., 2008) of the Basic Psychological Needs in Exercise Scale (Vlachopoulos & Michailidou, 2006). In addition, the novelty factor from the version validated by González-Cutre et al. (2016) and González-Cutre and Sicilia (2019) was incorporated. This instrument consists of 17 items grouped into four factors: autonomy (e.g., "The exercises I do suit my interests"), competence (e.g., "I think I can meet the demands of the class"), relatedness (e.g., "I feel that I can communicate openly with my classmates"), and novelty (e.g., "I think I often discover new things"). Items were preceded by the stem "In my Physical Education classes…" and answered on a Likert scale from 1 ("strongly disagree") to 5 ("strongly agree").

Intrinsic motivation and identified regulation in PE classes. We used the Spanish-tested version (Moreno et al., 2009) of the Perceived Locus of Causality Scale (Goudas et al., 1994) to assess these two SDT motivational variables. In this study, we used the intrinsic motivation dimension (e.g., "because Physical Education is fun") and the identified regulation dimension (e.g., "because it is important for me to do well in Physical Education"). The scale was introduced with the stem "I take part in this Physical Education class…" and responses were given on a Likert scale from 1 ("strongly disagree") to 7 ("strongly agree").

Measure of Intention to be Physically Active. We used the adapted and translated Spanish version (Moreno et al., 2007) of the Intention to be Physically Active Scale (Hein et al., 2004). The scale comprises five items (e.g., "I would like to belong to a sports club"). The stem used for these items was "Regarding your intention to take part in some physical-sport activity". Responses were obtained on a Likert scale from 1 ("strongly disagree") to 5 ("strongly agree").

2.4. Procedure

This study was approved by the Andalusian Research Ethics Committee (code: TD-DOC-EF-MOTIV-2020), and all ethical standards for research in Sport and Exercise Sciences were followed (Harriss et al., 2019).

The school management team and PE teachers were contacted to request their collaboration in the study. Subsequently, written informed consent was obtained from students' parents or legal guardians for their participation in the research.

2.5. Intervention or training of the teacher in the experimental group

The teachers were responsible for delivering the different PE sessions as they had planned for the duration of the study. The control-group teacher delivered

lessons in the usual way, without any manipulation. In contrast, the experimental-group teacher received personalised training to improve his BPN-supportive interpersonal style, which lasted approximately four months. The questionnaires (pre-test) were administered to all participating students before the start of the training/intervention with the experimental-group teacher (at the end of January). These questionnaires were administered again to students (post-test) four months after the start of the intervention (at the end of May).

The intervention consisted of continuous teacher training on motivational strategies based on BPN satisfaction (Ahmadi et al., 2023; Almagro et al., 2022). For this training, four PE lessons were recorded and evaluated using the Observational Tool for Motivational Interpersonal Climate (OCIM; Fierro-Suero et al., 2020) as a didactic resource. This procedure had a dual purpose: first, to observe the teacher's instructional behaviours during PE lessons, and second, to check whether the suggested motivational teaching strategies were being applied effectively. Two observers analysed the videos using OCIM; both were experts in observational instruments and in the topic (SDT applied to PE), with teaching experience in secondary-school and university PE. Intra-observer reliability was assessed using Cohen's Kappa and inter-observer reliability using Fleiss' Kappa, obtaining $K > .80$. After the video analysis, training meetings were held in which the strategies used by the teacher to satisfy students' BPN were discussed, as well as areas in which he should improve or place greater emphasis. Parts of the lessons were viewed, possible actions to improve teaching practice were reflected upon, and teaching resources were provided. This process lasted four months and included 7.5 hours of face-to-face training (90 minutes in each of the five meetings) and a further 7.5 hours of independent work (viewing and analysing PE lesson videos and reading supporting material with examples of motivational strategies for secondary PE classes). Thus, the experimental-group teacher's training lasted approximately 15 hours in total. This training programme is similar to that of Cantonero-Cobos et al. (2025), although in the present case it was aimed at improving the PE teacher's motivational interpersonal climate and leadership, and five face-to-face training sessions or meetings were used with the following structure and content:

1. Training meeting 1.

- Action 1.1. Awareness-raising and familiarisation with the topic (posing questions about students' motivation and interest in PE lessons and their consequences, presenting an overview of SDT applied to PE and its links with transformational leadership, and presenting examples of strategies for satisfying BPN).

- Action 1.2. Explanation of the observational instrument: Observational Tool for Motivational Interpersonal Climate (OCIM).
- Action 1.3. Teacher's overall self-assessment using OCIM dimensions/criteria (autonomy, competence, relatedness, and novelty).
- Action 1.4. Asynchronous online training by creating a group to share resources and queries (virtual environment).

2. Training meeting 2.

- Action 2.1. Teacher self-assessment using SWOT analysis (strengths, weaknesses, opportunities, and threats) in relation to his leadership style and the motivational climate he generates in PE lessons.
- Action 2.2. Teacher-led definition of specific proposals for improvement for upcoming sessions.
- Action 2.3. Provision of videos of two practical sessions for the teacher to observe his own lessons (virtual environment).

3. Training meeting 3.

- Action 3.1. Analysis of the observed sessions using OCIM and comparison between the teacher's ratings and those of the two researchers/observers.
- Action 3.2. Analysis of the ratings, reinforcement and consolidation of the goals achieved (e.g., continuing to use positive and questioning feedback, promoting autonomous behaviours, generating positive emotions).
- Action 3.3. Identification of new challenges to improve specific observed aspects.
- Action 3.4. Selection of resources and strategies to achieve these challenges (teaching and dissemination material). Delivery of another video of a PE session by the EG teacher (virtual environment).

4. Training meeting 4.

- Action 4.1. Repetition of the training cycle used in meeting 3, avoiding any loss of interest by the teacher in the training process.

5. Training meeting 5.

- Action 5.1. Repetition of the training cycle used in meeting 3 (without providing a PE session video).
- Action 5.2. Overall evaluation of the training and reflection on improvements in teaching practice.

2.6. Data analysis

Statistical analyses were carried out using SPSS version 29.0. First, the data matrix was cleaned, and an analysis was conducted to determine reliability (obtaining Cronbach's alpha values ≥ .70), as well as the normality of the variables (Shapiro–Wilk test, inspection of histograms and Q–Q plots, and skewness and kurtosis statistics). The results indicated a normal distribution of the data, with skewness and kurtosis values between -2 and 2 (George & Mallery, 2016) in both the experimental and control groups, and therefore parametric tests were used. Subsequently, independent-samples Student's t-tests were performed on pre-test data to determine

whether there were significant differences in the variables between the control and experimental groups before the intervention. Independent-samples t-tests were then carried out again with post-test data to examine whether any significant between-group differences in the study variables persisted after the intervention. Finally, paired-samples t-tests were conducted to assess within-group differences between pre-test and post-test. Additionally, a post hoc power analysis was conducted using G*Power for between-group comparisons of change scores (post–pre). With $n_1 = 45$ and $n_2 = 19$, $\alpha = .05$ (two-tailed), the power obtained was ≈ .11 for a small effect size (d = .20), ≈ .44 for a medium effect size (d = .50), and ≈ .82 for a large effect size (d = .80). This indicates that the sample used had adequate power only to detect large effects, which is a limitation that must be considered when interpreting the results.

3. Results

3.1. Preliminary analysis

As shown in Table 1, significant differences between the control and experimental groups were found in some of the study variables before the intervention. Therefore, the two groups presented different characteristics prior to the implementation of the intervention.

Table 1
Differences between the control and experimental groups before the intervention (pre-test)

	Control group		Experimental group				
Variables	*M*	*SD*	*M*	*SD*	t	*p*	α
Individual consideration	4.11	0.70	4.56	0.49	3.45	.00	.75
Idealised influence	3.60	0.66	4.38	0.43	2.80	.00	.73
Intellectual stimulation	3.63	0.84	3.82	0.84	.07	.42	.70
Inspirational motivation	3.79	0.84	4.42	0.60	4.56	.00	.79
Autonomy support	4.01	0.75	4.59	0.35	11.99	.00	.72
Competence support	4.07	0.81	4.64	0.40	18.74	.00	.72
Relatedness support	4.14	0.50	4.31	0.52	.08	.26	.70
Novelty support	3.45	0.80	4.06	0.63	1.19	.00	.74
Autonomy	3.26	0.85	4.02	0.79	.71	.00	.74
Competence	3.62	0.72	4.23	0.76	.01	.00	.77
Relatedness with others	3.91	0.94	4.41	0.74	1.41	.25	.80
Novelty	3.70	0.76	4.21	0.67	.81	.01	.79
Intrinsic motivation	5.46	1.10	5.94	1.03	.55	.10	.75
Identified regulation	5.57	1.00	5.72	1.11	.18	.60	.73
Intention to be physically active	3.73	1.04	4.12	0.95	.27	.15	.78

Note: *M* = Mean; *SD* = Standard deviation; *p* = significance; α = Cronbach's alpha.

3.2. Effects of the intervention

As shown in Table 2, there were significant differences in all study variables between the two groups (control and experimental) after the intervention.

Table 2
Differences between the control and experimental groups after the intervention (post-test)

	Control group		Experimental group				
Variables	*M*	*SD*	*M*	*SD*	t	*p*	α
Individual consideration	3.64	0.83	4.71	0.37	16.80	.00	.80
Idealised influence	3.49	0.92	4.47	0.61	5.62	.00	.77
Intellectual stimulation	3.71	0.89	4.49	0.58	6.56	.00	.84
Inspirational motivation	3.45	1.07	4.62	0.48	25.09	.00	.89
Autonomy support	3.72	0.86	4.68	0.38	31.06	.00	.80
Competence support	4.21	0.68	4.68	0.40	10.88	.01	.81
Relatedness support	3.91	0.82	4.58	0.51	12.99	.00	.79
Novelty support	3.24	0.86	4.51	0.66	1.99	.00	.80
Autonomy	3.05	0.96	4.46	0.56	5.77	.00	.82
Competence	3.54	0.91	4.56	0.43	20.06	.00	.78
Relatedness with others	3.99	1.02	4.58	0.46	13.95	.02	.84
Novelty	3.56	0.88	4.53	0.51	11.31	.00	.84
Intrinsic motivation	5.82	0.98	6.42	0.68	6.21	.02	.81
Identified regulation	5.34	1.15	6.28	0.74	6.64	.00	.79
Intention to be physically active	3.78	0.97	4.59	0.59	11.15	.00	.82

Note: *M* = Mean; *SD* = Standard deviation; *p* = significance; α = Cronbach's alpha.

Finally, to determine whether significant differences occurred within each group before and after the intervention, paired-samples t-tests were conducted. In the control group, a significant change was found in individual consideration (with a decrease in the mean score) and intrinsic motivation (which increased). In contrast, in the experimental group, significant differences were observed in most of the variables between pre-test and post-test, with higher mean scores after the intervention, as shown in Table 3.

Table 3
Within-group effects of the intervention

Variables		Control group					Experimental group				
		M	*SD*	t	*p*	*d*	*M*	*SD*	t	*p*	*d*
Individual consideration	Pre-test	4.11	0.70	2.34	.02	.86	4.56	0.49	-1.94	.03	.50
	Post-test	3.64	0.83				4.71	0.37			
Idealised	Pre-test	3.61	0.66	0.58	.29	.89	4.38	0.43	-0.95	.17	.59

influence	Post-test	3.49	0.92				4.47	0.61			
Intellectual stimulation	Pre-test	3.63	0.84	-0.52	.31	.67	3.82	0.84	-5.86	.00	.77
	Post-test	3.71	0.89				4.49	0.58			
Inspirational motivation	Pre-test	3.79	0.84	1.51	.07	.98	4.42	0.60	-2.26	.01	.59
	Post-test	3.45	1.07				4.62	0.48			
Autonomy support	Pre-test	4.01	0.75	1.70	.05	.74	4.59	0.35	-1.27	.11	.47
	Post-test	3.72	0.86				4.68	0.38			
Competence support	Pre-test	4.07	0.81	-1.02	.16	.62	4.64	0.40	-0.51	.31	.51
	Post-test	4.21	0.68				4.68	0.40			
Relatedness support	Pre-test	4.14	0.50	1.46	.08	.71	4.31	0.52	-2.93	.00	.62
	Post-test	3.91	0.82				4.58	0.51			
Novelty support	Pre-test	3.45	0.80	1.11	.14	.83	4.06	0.63	-3.88	.00	.77
	Post-test	3.24	0.86				4.51	0.66			
Autonomy	Pre-test	3.26	0.85	0.92	.19	.99	4.02	0.79	-4.24	.00	.70
	Post-test	3.05	0.96				4.46	0.56			
Competence	Pre-test	3.62	0.72	0.57	.29	.61	4.23	0.76	-3.53	.00	.62
	Post-test	3.54	0.91				4.56	0.43			
Relatedness with others	Pre-test	3.91	0.94	-0.29	.39	1.19	4.41	0.74	-1.92	.03	.62
	Post-test	3.99	1.02				4.58	0.46			
Novelty	Pre-test	3.70	0.76	0.68	.25	.89	4.21	0.67	-3.36	.00	.64
	Post-test	3.56	0.88				4.53	0.51			
Intrinsic motivation	Pre-test	5.46	1.10	-1.89	.04	.82	5.94	1.03	-3.48	.00	.92
	Post-test	5.82	0.98				6.42	0.68			
Identified regulation	Pre-test	5.57	1.00	1.06	.15	.73	5.72	1.11	-4.05	.00	.93
	Post-test	5.34	1.15				6.28	0.74			
Intention to be physically active	Pre-test	3.73	1.04	-0.26	.40	.78	4.12	0.95	-3.94	.00	.81
	Post-test	3.78	0.97				4.59	0.59			

Note: *M* = Mean; *SD* = Standard deviation; *t* = statistic; *p* = significance; d = Cohen's d[1].

[1]Cohen's d = effect size, with d = 0.2 (small), d = 0.5 (medium), and d = 0.8 (large).

4. Discussion

The purpose of this study was to analyse the effects of changes in the motivational interpersonal climate generated by the PE teacher on students. In this regard, the results show the positive effects that an intervention on the PE teacher's

motivational interpersonal climate has on students' perceptions of the teacher's leadership and support for their BPN, on their BPN satisfaction, on autonomous motivation, and on their intention to be physically active.

Scientific literature (e.g., Moreno-Casado, 2023; Sevil-Serrano et al., 2014) supports the idea that when teachers show interest in their students and highlight their role, there is a positive trend in various motivational variables. In this context, it seems vitally important that PE teachers seek to satisfy students' BPN by fostering an appropriate motivational interpersonal climate. Indeed, several studies have shown that teachers can learn strategies to teach in ways that offer more autonomy to their students (Aelterman et al., 2014; Reeve & Cheon, 2021), and that improvements in the motivational interpersonal climate (Lamoneda-Prieto et al., 2024; Moreno-Murcia & Sánchez-Latorre, 2016), as occurred in this study, lead to positive effects on students' motivation and intention to be physically active.

As hypothesised, the within-group analysis of the effects of the teaching intervention showed positive changes in the experimental group in the following variables: inspirational motivation, individual consideration and intellectual stimulation (as regards teacher leadership); relatedness support and novelty support; satisfaction of autonomy, competence, relatedness and novelty; intrinsic motivation; identified regulation; and intention to be physically active. Some of these findings are consistent with previous studies using similar interventions (e.g., Fin et al., 2019; Sánchez-Oliva et al., 2017). However, the present study also reports results that had not previously been tested, such as evidence that an SDT-based intervention can improve students' perceptions of certain dimensions of the PE teacher's transformational leadership style.

In the control group, the comparison of pre-test and post-test mean scores showed few changes in the variables analysed, except for individual consideration, which did show statistically significant differences, with a decrease in the mean score. The other variable that changed significantly was intrinsic motivation, whose mean increased. This was an unexpected result, which could be explained by the absence of any manipulation of the methodology or content used by the teacher. The use of attractive content or active methodologies (Fernández-Espínola et al., 2020; Real-Pérez et al., 2021) could account for this improvement in students' intrinsic motivation. Even so, the results obtained in the experimental group support the benefits of specific SDT-based training in motivational and need-support strategies to enhance need satisfaction, motivation and the intention to remain physically active outside school.

Another noteworthy finding is the increase, in the experimental group, in both perceived novelty-support strategies and satisfaction of the need for novelty. These results are in line with those reported by Castillo-Roy et al. (2021), as well as by Gil-Arias et al. (2021), who also found improvements in novelty satisfaction along with other variables (BPN satisfaction, intrinsic motivation, etc.).

Overall, this study has shown that specific training aimed at improving the motivational interpersonal climate generated by the PE teacher has a positive effect on students' perceptions of the teacher's leadership, of his/her need-supportive behaviours, on BPN satisfaction, on more autonomous forms of motivation, and on the intention to be physically active. It is worth highlighting that the training was delivered over the four months during which the intervention took place, focusing on motivational strategies to satisfy BPN (Ahmadi et al., 2023; Almagro et al., 2022) and using video recordings of the teacher's behaviour analysed with OCIM (Fierro-Suero et al., 2020) to implement specific improvements to the experimental teacher's motivational interpersonal climate throughout the process. In future research, it would be interesting to determine which characteristics a motivational-strategy training programme should have in order to be effective, given that programmes with different types of interventions for PE teachers have yielded positive results (Fernández-Espínola et al., 2022).

Despite these findings, this study presents limitations that should be taken into account in future research. First, the sample size was relatively small, which may affect the generalisability of the results. It would therefore be of interest to increase the sample and examine whether the findings are replicated in other schools and with other teachers undertaking the same training. Another limitation is that, although the training received by the experimental-group teacher was monitored during the process (through training meetings, recordings of several PE lessons, etc.), it would also be useful to control for possible contamination or influence from the other teacher in their day-to-day interaction within the same school, as well as to examine how the type of content taught at any given time may affect students' motivation. In any case, the findings of this study may inform various practical applications in PE teacher training and guide future research.

5. Conclusions

Systematised training in motivational strategies based on satisfying students' BPN by the PE teacher has a direct impact on the quality of the teaching–learning process. It not only promotes good educational practice on the part of the teacher, but, as stated in the national curriculum establishing the minimum requirements for compulsory secondary education and Baccalaureate (Real Decreto 217/2022; Real Decreto 243/2022), it also contributes to meeting key challenges related to students, such as consolidating an active lifestyle and developing eco-socially responsible attitudes, among others.

This study confirms that training focused on the motivational interpersonal climate improved the teacher's leadership, need-supportive behaviours, BPN satisfaction, more self-determined forms of motivation (intrinsic motivation and identified regulation), and the intention to be physically active in the experimental group. In short, by the end of the intervention, differences were found in all study variables between students in the control and experimental groups, in favour of the

experimental group, which obtained higher mean scores. This highlights the usefulness of this type of teacher-focused intervention for optimising students' motivational processes in PE lessons.

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